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(54)【発明の名称】　ソーラー・アレーの製造方法

1

【特許請求の範囲】

【請求項１】複数の開口を有するアルミニウム箔を用意し、

各々がＰ形領域とＮ形領域を有する複数の半導体部材を、その各Ｎ形領域が前記アルミニウム箔の各開口にオ

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従来の技術及び問題点

太陽光線を他の形の有用なエネルギに変換することによつてエネルギを発生する装置はよく知られており．太陽が主なエネルギ源であるという経済性の為、こういう装置は絶えず開発され且つ改良されている。この様な１つ

続される。シリコン粒子の表皮部がマトリクスの前側から伸出す。こういうアレーは、マトリクスの前側と接触する電解質、好ましくは臭化水素酸（HBr）内に浸漬する。電解質と接触する異なる導電型のシリコン粒子の間の電位差の為、HBrを泡立つ水素ガスと溶解したままになつている臭素とに電気分解する太陽光の下で、その間に電位差が設定される。水素ガスを収集し、例えば燃料電池等の様なエネルギ源とするが、これは周知である。こういう形式のソーラー・アレーではシリコン粒子が電気分解に独立に参加する。その結果、アレーによつて反応生成物が発生される速度は、若干の粒子のP－N接合が短絡し又は分路されても、あまり影響を受けない。

太陽光線から有用なエネルギを発生する別の装置は、上に述べた種類と同様であるが、電気分解を行なわずに、電力を発生する様に構成されている。この様な1つの装置が米国特許

第2,904,613号に記載されている。その他の構成も可能であるが、役に立つ実施例は、硝子又はプラスチックの様な透明マトリクスにP形表皮部を持つN形シリコンの粒子を設けて構成される。粒子のN形のコアがマトリクスの裏側から突出し、適当な導電メタライズ部分によつて相互接続される。P形表皮部がマトリクスの前側から突出し、細い金属格子の上の酸化錫の様な導電性で透光性の材料によつて相互接続される。太陽光の下では、このアレーの後側及び前側の相互接続部の間に電位差が設定され、それを適当に接続して、外部の電気負荷に直接的に給電することが出来る。

この技術の改良が米国特許出願

第562,782号に記載されている。この出願には、前に述べた発明の改良が記載されている。然し、現状では、上に述べた従来の方法に従つて、ソーラー・セルを製造するコストはあまり経済性がなく、この従来の方式はこれまで経済的に大きな成功を収めていない。従つて、経済的に成り立ち得るソーラー・セルを供給する為には、こういうアレーを比較的高価ではなく製造出来ることが絶対条件である。

問題点を解決するための手段及び作用

この発明では、上に述べた従来の問題を大幅に削減し、前に引用した従来技術と較べて、ソーラー・アレーを経済的に製造することが出来る様なソーラー・アレーの製

れに適用すべき球に対するハウジングを形成すると共にその前側接点を形成する。P形の上にN形表皮部を持つシリコンの球を箔の表側にデポジットし、箔の裏側に真空チャックを設けて、球を前以つて形成した開口に吸込み、その中に途中まで入れて、空気がこの開口を通過することを遮断する。最初は開口の数に較べて過剰の数の球を使うので、最終的には全ての開口が球で埋められ、その後使われなかつた球は、箔の後面をブラッシング等することによつて除去される。

次にシリコンの球をインパクト・プレスを使うことによつてアルミニウム箔に結合する。このプレスが球を開口の中に押込み、球の赤道が箔より上方にあつて、箔の表側（太陽又は光の方を向いた側）に来る様にする。強い力で球を開口の中にこの様に押込むことにより、シリコンの球と接触した表面のアルミニウムが裂け、その場所で新鮮なアルミニウムが露出する。アルミニウムに対するシリコンの球の移動によつて生ずる剪断により、表面の参加アルミニウムも削り落されて、この様な露出した新鮮なアルミニウムが得られる。この作用は、アルミニウム箔、特に露出したアルミニウムと接触する球の部分から、酸化シリコンの実質上全部を除去する。この作用は、約500℃乃至577℃未満の範囲内の温度にアルミニウムをおいて行なわれ、この時、アルミニウムは固体であるが変形し易くなり、これに対してシリコンはこの温度では依然として剛体である。（インパクトの持続時間が十分短かければ、577℃より高い温度にすることも出来る。）新鮮なアルミニウムが2酸化シリコンを浸食し、インパクトの際、インパクトを加えた場所で実質的にそれを除去する。この様にして、シリコンとアルミニウムの間の結合が得られ、シリコンのN形表皮層に対するアルミニウム接点が形成される。この後、箔と球から成るアレーを周囲温度まで冷却して、箔が再び硬化するのに任せる。

次に、球が露出している箔の裏側をエッチして、そこにあるN形表皮部を除去する。これは、アルミニウム箔がシリコン・エッチャントに対するマスクとして作用するからである。箔自体は、普通はその上にごく薄い自然の酸化物コーティングが形成されている為に、あまり反応性はない。次にアレーを硫酸バス（bath）（約10%H_2SO_4）内に約1/2分間入れアレーを陽極酸化し、アルミニウ

を形成する。

リール形実施例でアレーを形成する場合、第2の箔を球に結合する前に、隣接するアレーの間の場所で、表皮部を2つの箔の間に配置する。この実施例では、第2の箔を球に結合する際、上側及び下側の箔を表皮部に押付けるが、それと結合はしない。その後、アレーの両側で、表皮部の上で箔を適当にけがき、アレーの両側で、各々の箔に対する箔延長部を設ける。次にこの箔延長部を直列回路に互いに接続して、拡大回路を形成することが出来る。

上に述べた様な表皮部を持つアレーをけがき、互いに分離し、面取りして、長方形のアレーの片側だけが接点の形で外向きに伸びる第2の箔部分を持つ様にすることが出来る。こう言う接点を他のアレーの第1の箔部分に任意の幾何学的な形で接続して、入力及び出力を持つモジュールを作る。

その結果、各々のシリコンの球のおもな部分がアレーの前側に配置されて太陽光線を受取る為に利用し得る表面の大きさを大きくしたソーラー・セルが得られる。更に、当然ながら、このアレーは可撓性であり、アルミニウム箔に光反射器を持つており、比較的少数の硬化ではない材料及び処理工程を用いて提供される。

実施例

第1図及び第2図には、この発明に従つてソーラー・アレーを形成する為の、この発明の特徴を利用した処理工程が略図で示されている。最初、厚さ約2ミルのアルミニウム箔1を用意する。この箔は可撓性であつて、環境に対して普通に露出している為に、その表面にごく薄い自然の酸化物層を持つているのが普通である。以下の説明はソーラー・アレーの1個の部材に関するものであるが、前に説明した従来技術から判る様に、アレー全体には多数のアレー部材があることを承知されたい。

最初にアルミニウム箔1を（a）に示す様に周期的な6角形の配置で、例えば中心間15ミルで打出し、厚さが薄くなつた打出し部3は、その中に配置しようとする球の直径より若干小さい直径にする。打出し部は円形又は6角形の様なその他の幾何学的な形であつてよい。多角形の打出しの場合、中心を通つて多角形を横切る線は、これに適用する球の直径より小さくする。次に、箔を洗浄して有機物を除去し、その後（b）に示す様に熱した水

グにより、箔に或る生物を持たせ、後方反射を最小限に抑えるマトリクス面を作ることが出来る。

（c）に示す様に、N形表皮部9及びP形内部11を持つ複数個のシリコンの球7を箔1上のマトリクスの上側15にデポジットし、真空チャックを用いて箔の裏側13に真空を加えて、球7を開口5の中に引込む。最初に箔の裏側では、開口5の数に比べて過剰の球7を用いるので、全ての開口が球7で埋まり、その後過剰の球7がブラシがけ等により、箔1の上側から除去される。ここで用いる球は直径が14.5ミルであることが好ましく、前に述べた様に、開口5の断面直径は14.5ミルより小さく、箔の裏側で箔に真空がかけられるが、その理由は後で説明する。

この後、（d）に示す様に、箔を加熱し、ついでインパクト・プレスを使うことにより、球7がアルミニウム箔1の開口5の中に結合される。この時、球7が素早く開口5の中に押込まれ、開口内に剪断作用を生じ、それが開口の所の箔の内面にある酸化アルミニウムを削取り、新鮮なアルミニウム元素を露出する。前に述べた様に、球7が開口5の中に押込まれる時にアルミニウムは530℃の温度に加熱されており、この為アルミニウムは反応性であつて、機械的な性質が幾分粘性を持ち、用意に変形する。従つて、元素のアルミニウムが球の上にある非常に不水自然の酸化シリコン層と反応して、それを除去し、この為箔1のアルミニウムがこの時球のN形層9内にあるシリコン元素と直接的に接合して、それに対する接点を形成することが出来る。

球の赤道がアルミニウム箔1により上方、又はその上方15にある様に、球7が開口5内に配置される。こういう配置は、アルミニウム箔1の上下に配置された圧力パッドを使うことによつて可能になる。圧力パッドはクッションとして作用する窒化硼素の粉末の様な離型剤で被覆した厚さ約8ミルのアルミニウム箔で形成されており、この為、インパクト・プレスのハンマーがインパクトを加える際に球を損傷することがない。更に、圧力パッドがハンマーの衝撃を吸収する。箔1の15側にある上側の圧力パッドで箔1の13側にある下側の圧力パッドよりも厚手であつて、前に述べた様に、球の赤道が箔からずれる様にする。2cm平方のアレーに対し、約48フィート・ポンドのインパクト・エネルギが首尾よく作用すること

様に．約20ボルトで約1/2分間の間、10%H_2SO_4溶液内でアレーを陽極酸化して、露出したシリコン及び箔を不働態化する。次に約20ボルトで約1/2分間0.5%H_3PO_4溶液内でアレーを陽極酸化する。陽極酸化に要する時間は、バスの電流がゼロになつて打切られる時の関数であり、これが約1/2分であることが判つた。燐酸を使うことが重要であり、これは酸化アルミニウム内の孔を塞ぎ、前にエッチしたシリコン表面に約1,000Aの酸化物層21を作ることが判つた。

次に．陽極酸化の際に形成された後側21を周知の方法で機械的に削磨することにより、陽極酸化したアレーの球7をラップする。このラッピングにより、2酸化シリコン21及び若干のシリコンの両方が除去されて、球7の後面17が平坦になり、17に示す様に粗面が得られ．この為その上にオーミック接点を形成することが出来る。次に．約1/2ミルのアルミニウムの薄箔19を（h）に示す様に各々の球7の後面17の上に配置して、それがラップした平坦な領域17の上に来る様にする。このアルミニウムは好ましくは530℃の温度、又は約500乃至577℃の範囲内の温度に加熱するが．前に述べた様な条件がある。加熱された箔19がこの後インパクト・プレスによつて球7に圧着され．このインパクトによつて露出したアルミニウムと、ラッピング並びにアルミニウム元素によるインパクトの為に球7の後面で露出したシリコンとの間の結合部が形成される。前に（d）について述べたのと同じ様に結合を行なうことにより、シリコン領域11に対する箔の接点19が形成される。アルミニウム箔1の陽極酸化の為、この箔の表面の上には厚い酸化アルミニウムがあつて、箔1の及び箔19の間の短絡を防止する。

（（i）に示す様に、アレーの前側の面の上に標準的な反射防止コーティングを適用し、シリコンの光の吸収を改善することが出来る。）従つて、シリコンの球の大部分が入射する太陽光線に露出し、アレーが可撓性であつて．使われる処理並びに使われる材料が比較的高価でなく且つ数が少ない様にして．ソーラー・アレーが提供されたことが理解されよう。

実際の処理工程では、上に述べた様なアレーは．別々のアレーとしてではなく、リール形の実施例で設けるのが普通である。その後、アレーは寸法が例えば1m×2mである様なモジュールに形成され．こういう設計のままで試

る。第4図（a）から判る様に、前側の箔33は後側の箔35より寸法が小さいが、その理由は後で明らかになる。次に第3図（b）を見ると．この時後側の箔35が球31及び37と接触していることが判る。上側の箔33もシムと接触している。これは第1図の工程（h）で、この処理工程の一部分として後側の箔35を球31に結合する時に達成される。箔33,35はシム37に接着せず、単にそれと接触しているだけである。この後、次にシムの上の．第3図（b）のV字形記号の場所で箔をけがき、アレーを互いに分離し且つシムを取外した後、第3図（c）及び第4図（c）に示す様な装置を作る。次に第3図（c）及び第4図（b）に示す様なアレーを第4図（c）に示す様に面取りして．後側の箔35の一部分である4つの耳を作る。これらの耳はアレーの四角の各辺にあつて．A,B,C,Dと記してある。次に第3図（d）及び第4図（d）に示す様に、耳B,C,Dをアレーの下に折返し．その後第3図（e）に示す様に、超音波結合等により、耳Aをこの後．アレーの耳B,C又はDの内の1つに結合することにより．このアレーをこの後のアレーに固定する。

相互接続工程は第5図の3次元表示の装置で示す様に行なうことが出来る。この装置では、耳Aが伸出している1つのアレーを．別のアレーの耳B,C又はDの内の1つのこの耳Aとが接触する様に位置ぎめする。この手順を直線又はその他の通路で続けて、完全なモジュールを作る。完成されたモジュールが第6図に示されており、耳Aが隣接するアレー30の耳B,C又はDに固定されて、60個のアレーの直列回路を形成する前後に配置された通路を作る。更に．モジュールに対する入力41及び出力43となる耳を設ける。

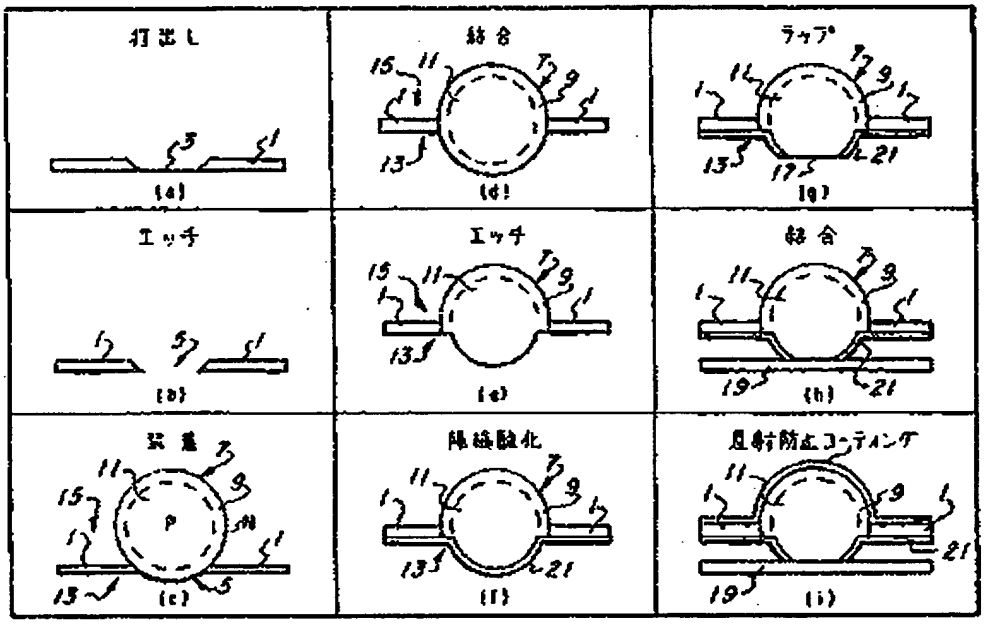
第6図のモジュールを形成した後、第2図について説明すると、モジュールを試験し、試験に成功すれば．モジュールは支持材料等に取付られる工程に進み、その後結合部で耳を超音波で結合し．その後モジュールをカプセル封じして、環境に対する適当な封じを施す。次にカプセル封じしたモジュールを標準的に試験し、動作し得るモジュールが使える状態になる。以上の様に、本発明によるソーラー・アレーは500℃以上の温度下での加圧により第1アルミニウム箔の開口にオーミック接触結合したN形領域を有する半導体部材を含むことを特徴の一つとする。この特徴により．半導体部材を第1アルミニウ

ロセスを示すプロセス線図．第３図は１次元で表わしたアレー相互接続手順を示す略図、第４図は２次元で示したアレー相互接続手順を示す略図、第５図は３次元で表わしたアレー相互接続を示す略図、第６図はこの発明のモジュールの略図である。

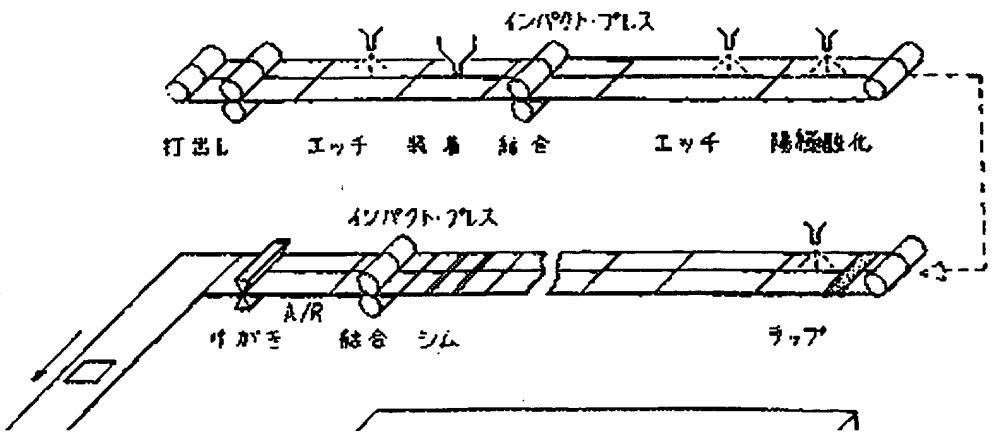
符号の説明

＊1:第１のアルミニウム箔
5:開口
7:シリコンの球
9:N型表皮部
11:P型内部
＊19:第２のアルミニウム箔

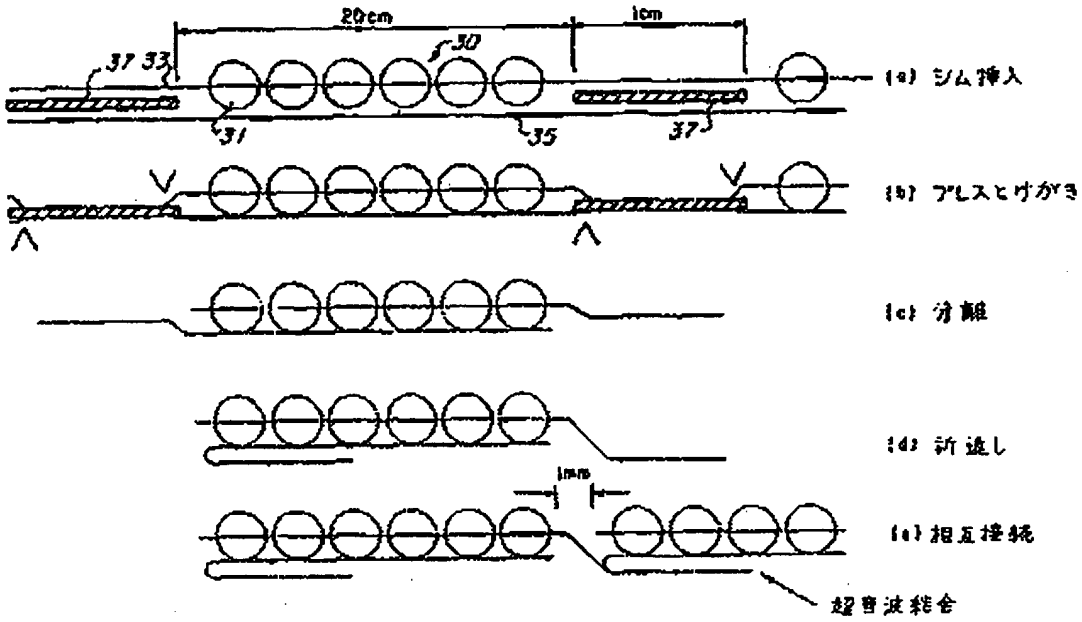
【第１図】



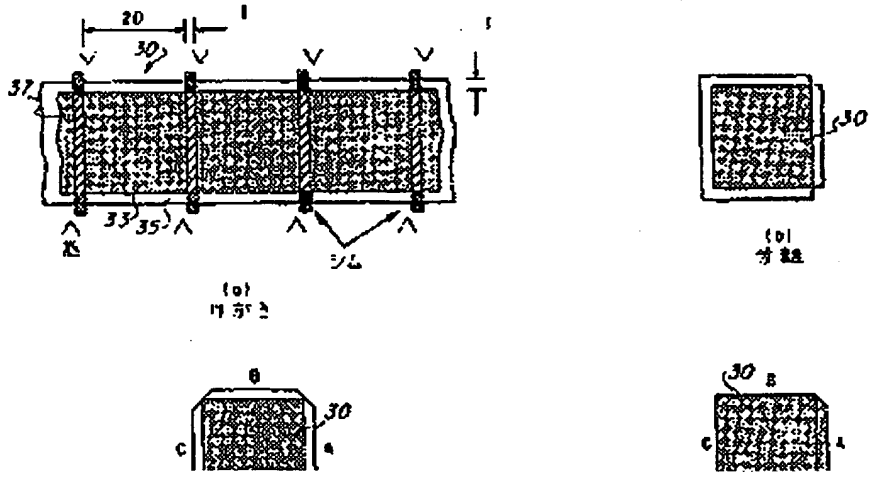
【第２図】



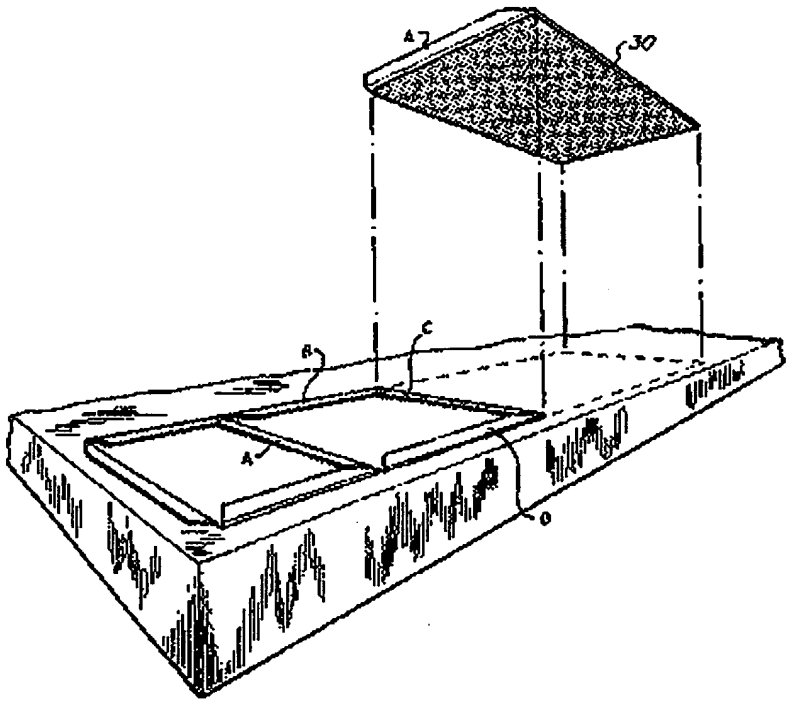
【第3図】


20cm
1cm
30
37 33
31
35
37
(a) シム挿入
(b) プレスヒゲがき
(c) 分離
(d) 折返し
1mm
(e) 相互接続
超音波溶着

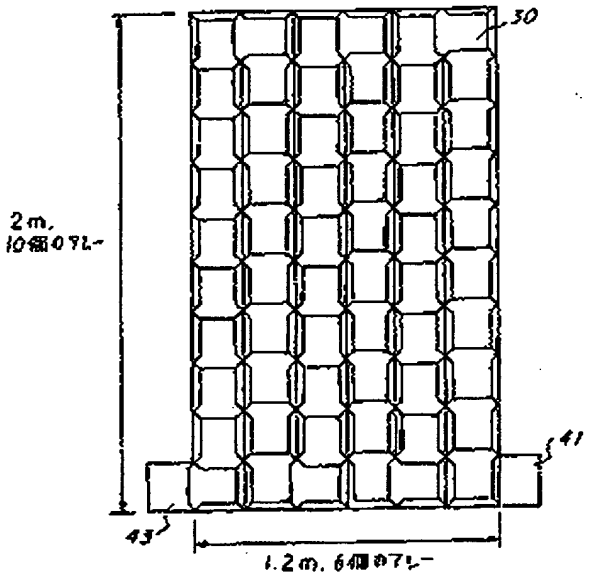
【第4図】


20
30
31
33
35
T
シム
(a)
30
(b)
分離
B
30
C
A

【第5図】



【第6図】



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CLAIMS

[Claim(s)]
[Claim 1] The manufacture approach of a solar array including the process which combines with the P form each field of two or more of said semi-conductor members the contact member which prepared the aluminium foil which has two or more openings, pressurized two or more semi-conductor members in which each has a P type field and an N type field under the temperature of the range of 500 to 577 degrees C so that the N form each field might carry out ohmic contact association at each opening of said aluminium foil, and was insulated from said aluminium foil.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[nvention of ********** on industry relates to the approach of making the solar battery (solar cell) generated when it exposes from the ball of the silicon arranged in a metallic foil matrix.
The equipment which therefore generates energy to change a Prior art and trouble sunrays into the useful energy of other forms is known well, and since it is the economical efficiency in which the suns are the main energy sources, such equipments are developed continuously and improved. Such one equipment is indicated by U.S. Pat. No. 4,021,323, and the solar array which embedded and prepared in the matrix the particle of the silicon of the P type which has the N type epidermis section at that one side, or the N type silicon which has the P type epidermis section in that one side at the solar array which consisted of transparent matrices like glass or plastics is indicated by this United States patent. This configuration is changeable although it is desirable that it is the P type in which a half particle has the N type epidermis section generally, and is the N type in which the remainder has the P type epidermis section. Therefore on the background of a matrix, the projecting particle interconnects into a suitable electric conduction metallizing part. The epidermis section of a silicon particle is ****** from a before [a matrix] side. the electrolyte with which such arrays contact a before [a matrix] side -- it is preferably immersed in a hydrobromic acid (HBr). The potential difference is set up between them under the sunlight electrolyzed into an intermediary **** bromine as HBr was dissolved with the foaming hydrogen gas for the potential difference between the silicon particles of a different conductivity type in contact with an electrolyte. This is common knowledge, although hydrogen gas is collected, for example, being considered as energy sources, such as a fuel cell.
[n the solar array of such formats, a silicon particle participates independently of electrolysis. Consequently, the rate at which a resultant is therefore generated at an array is seldom influenced, even if the P-N junction of some particle connects too hastily or a shunt is carried out.
Although it is the same as that of the class described above, another equipment which generates useful energy from sunrays is constituted without electrolyzing so that power may be generated. Such one equipment is indicated by U.S. Pat. No. 2,904,613. Although other configurations are also possible, a helpful example prepares the particle of the N type silicon which has the P type epidermis section in a transparence matrix like glass or plastics, and is constituted. Therefore, the core of the N type of a particle interconnects into a projection and a suitable electric conduction metallizing part from the background of a matrix. Therefore, the P type epidermis section interconnects into the ngredient of translucency by conductivity like the tin oxide on a projection and a thin metal grid from a before [a matrix] side. Under sunlight, the potential difference can be set up between the interconnect sections after this array and by the side of before, it can be connected suitably, and electric power can be directly supplied to external electric load.
Amelioration of this technique is indicated by the United States patent application No. 562,782. Amelioration of nvention described above is indicated by this application. however, the conventional approach stated above in the present condition -- therefore, the cost which manufactures a solar cell does not not much have economical efficiency, and this conventional method has not stored the big success economically until now. Therefore, in order to supply the solar cell which may be realized economically, it is conditions absolutely that it is not comparatively expensive and such arrays can be manufactured.
n the means for solving a trouble, and invention of ******, the conventional problems described above are reduced sharply and the process of the solar array which can manufacture a solar array economically is offered compared with

the conventional technique quoted before.
If it says simply, in this invention, the 1st sheet of the flexible aluminium foil of the normal mode which is considered to have a natural aluminum oxide in that front face will be prepared, and a solar array will be formed. A foil is hammered out in the location which should arrange the ball of silicon, and a metal matrix is formed. then, a foil -- beautiful -- carrying out -- the organic substance -- removing -- printing -- ******** -- it etches in order to remove a thin area and to make opening there, and the location for inserting a silicon ball is made. A mat side (matte surface) is made in a foil using another etching process. While a foil forms housing to the ball which should be applied to it, the before side contact is formed. It intercepts that carry out the deposit of the ball of the silicon which has the N type epidermis section on P type to the side front of a foil, prepare a vacuum chuck in the background of a foil, absorb to opening which formed the ball beforehand, put in to the middle into it, and air passes this opening. Since a superfluous number of balls are used compared with the number of openings at first, finally all openings are buried with a ball, it is used after that, and, therefore, inside ****** is removed by that PURATSUSHINGU etc. carries out the rear face of a foil.
Next, therefore, the ball of silicon is combined with using an impact press at aluminium foil. This press pushes in a ball into opening and it is made for the equator of a ball to come to the side front (side which turned to the sun or the light) of ****** and a foil more nearly up than a foil. By pushing in a ball into opening by the strong force at this appearance, the aluminum of the front face in contact with the ball of silicon splits, and fresh aluminum is exposed in that location. Surface participating aluminum is also cut off by the shear therefore produced in migration of the ball of the silicon to aluminum, and such exposed fresh aluminum is obtained by it. This operation removes all from the part of the ball in contact with aluminium foil, especially the exposed aluminum on the parenchyma of silicon oxide. This operation is performed by setting aluminum to the temperature of about 500 degrees C thru/or less than 577 degrees C within the limits, at this time, although aluminum is a solid-state, it is [become] easy to deform, and silicon is still the rigid body at this temperature to this. (The persistence time of impact can also make it enough short ******** and temperature higher than 577 degrees C.) Fresh aluminum corrodes diacid-ized silicon and it is substantially removed in the location which added impact in the case of impact. thus, association between silicon and aluminum obtains -- having -- the N type table of silicon -- a cortical layer -- the aluminum contact which carries out pairs is formed. Then, he leaves it to cooling the array which consists of a foil and a ball to ambient temperature, and a foil hardening again.
Next, the background of the foil which the ball has exposed is slept together and the N type epidermis section which is there is removed. This is because aluminium foil acts as a mask to silicon etchant. Since, as for the foil itself, natural oxide coating very thin on it is usually formed, there is no reactivity not much. Next, about 1/of arrays is put in for 2 minutes in a sulfuric-acid bus (bath) (about 10%H2SO4), an array is anodized, and oxide coating is prepared on aluminum. Next, in order to seal aluminum and to anodize silicon, another anodization bus containing 0.5%H3PO4 is used. Thus, about 10 micrometers aluminum 2O3 and 0.1-micrometer SiO2 grow. Next, the lap of the rear face of a ball is carried out, and the field for making it contact is established. Surface roughening of this field is carried out by the lap process, and OMITSUKU good for this reason comes to be formed of it. Next, after applying to the field which carried out the lap of the 2nd foil of thin aluminum and carrying out a preheating to the temperature of 500 degrees C thru/or less than 577 degrees C within the limits, an impact press is carried out and the contact over this field is formed in the field which carried out the lap of the foil.
When forming an array in the reel form example, before combining the 2nd foil with a ball, the epidermis section is arranged between two foils in the location between adjoining arrays. It and association are not carried out, although the foil of a top and the bottom is pushed against the epidermis section in this example in case the 2nd foil is combined with a ball. Then, a foil extension [as opposed to each foil for a foil] is suitably prepared by the both sides of a marking-off and an array on the epidermis section on both sides of an array. Next, this foil extension of each other can be connected to a series circuit, and an expansion circuit can be formed.
It can have a marking-off and the 2nd foil part to which it dissociates mutually, it bevels and only one side of a rectangular array is extended outward in the form of a contact for an array with the epidermis section which was described above. The contact said like this is connected to the 1st foil part of other arrays in the geometric form of arbitration, and a module with an input and an output is made.
Consequently, the solar cell which enlarged magnitude of the front face which can be used in order to arrange the main parts of the ball of each silicon at a before [an array] side and to receive sunrays is obtained. Furthermore, though natural, this array is flexibility and is offered using ****** which has a light reflex machine in aluminium foil, the

ingredient which is not a small number of hardening comparatively, and down stream processing.
Figs. 1 and 2 of an example -- this invention -- therefore, down stream processing using the description of this invention for forming a solar array is shown by schematic drawing. At first, the aluminium foil 1 with a thickness of about 2 mils is prepared. Since it has exposed ordinarily to ****** and an environment by flexibility, this foil has that common of ****** which has a very thin natural oxide layer in that front face. Although the following explanation is related with one member of a solar array, please permit the whole array for there to be many array members so that the conventional technique explained above shows.
As aluminium foil 1 is first shown in (a), it is arrangement of six periodic square shapes, for example, it hammers out by 16 mils of centers to center, and thickness makes the ****** printing section 3 thinly a diameter [a little] smaller than the diameter of sphere which it is going to arrange in it. ****** of the printing section is good in the geometric form of circular or others like six square shapes. the case of printing of a polygon -- a core -- a connoisseur -- the line which crosses an intermediary polygon is made smaller than the diameter of sphere applied to this. Next, a foil is washed, the organic substance is removed and it sleeps together using the sodium hydroxide or potassium heated as shown in (b) after that, and while removing the field which made the printing section 3 among foils, opening 5 is formed in the location. During etching, since it is much more thinner than other parts of a foil, while being removed ahead of other parts of a foil, also in order to make cold working by printing performed there, as for the printing field 3, sleeping together is still quicker. This is called an aluminum matrix.
Optional selection, 60%, by etching using 25%HF and 50% solution of the etchant which is HNO3 and 15% glacial acetic acid, a certain living thing can be given to a foil and the matrix side which suppresses back reflection to the minimum can be made from this point.
As shown in (c), the deposit of the ball 7 of two or more silicon with the N type epidermis section 9 and the interior 11 of P type is carried out to the matrix bottom 15 on a foil 1, a vacuum is added to the background 13 of a foil using a vacuum chuck, and a ball 7 is drawn into opening 5. First, since the superfluous ball 7 is used compared with the number of openings 5, all openings are buried with a ball 7 and the superfluous ball 7 is removed from the foil 1 bottom by the brush cliff etc. after that on the background of a foil. Although it is desirable that a diameter is 14.5 mils as for the ball used here, the cross-section diameter of opening 5 is smaller than 14.5 mils to the appearance described above and a vacuum is applied to a foil on the background of a foil at it, the reason is explained later.
Then, as shown in (d), a ball 7 is combined in the opening 5 of aluminium foil 1 by heating a foil and subsequently using an impact press. At this time, a ball 7 is quickly pushed in into opening 5, a shear operation is produced in opening, the aluminum oxide which has it in the inside of the foil of the place of opening is shaved off, and a fresh aluminum element is exposed. for this reason, aluminum ****** [when / at which it stated above / a ball 7 is pushed in into opening 5 / aluminum is heated by the temperature of 530 degrees C and] like, and is mechanical at reactivity -- a what property has viscosity a little and deforms into preparation. Therefore, the aluminum of an element can join to the silicon element on a ball which reacts with the silicon oxide layer of non-water nature very much, removes it, and has aluminum of a foil 1 in the N type layer 9 of a ball at this time for this reason directly, and can form the contact over it.
A ball 7 is arranged in opening 5 at the appearance which has the equator of a ball in the upper part or its upper part 15 with aluminium foil 1. Therefore, such arrangement is attained using the pressure pad with which aluminium foil 1 has been arranged up and down. The pressure pad is formed with aluminium foil with a thickness of about 8 mils covered with a release agent like the powder of boron nitride which acts as a cushion, and for this reason, a ball is not damaged in case the hammer of an impact press adds impact. Furthermore, a pressure pad absorbs the impact of a hammer. It is made for the equator of a ball to shift from a foil to ****** and the appearance described above in thick rather than the pressure pad of the bottom which is in 13 side of a foil 1 with the pressure pad of the top in 15 side of a foil 1. It is ****** to 2cm square of array that the impact energy of about 48 feet pounds acts with the sufficient result. For this reason, it is as having stated above that aluminum is directly combined with silicon at this time.
As the part which is in a this side the field 13 on the backside [a foil 1] and among balls 7 is shown in (e) after this, it sleeps together using etchant, and the part which is on an array rear face among the N type layers 9 is removed, and a P type field is exposed. The aluminium foil 1 which has natural oxide on it acts as a mask to this etchant, and it enables it to remove only the part of the layer 9 in backside [an array] 13. Then, as an array is washed by deionized water and it is shown in (f) below except for etchant, an array is anodized in [about 1/] 2 minutes and within 10%H2SO4 solution by about 20 volts, and passivation of the silicon and the foil which were exposed is carried out. Next, an array is anodized by about 20 volts within 0.5%H3POduring about 1-/2 minutes4 solution. the time amount which anodization

takes -- the current of a bus -- zero -- it is a function at the time of intermediary close ****, and this is about 1 / 2 minutes -- ******. It is ****** to make about 1,000A oxide layer 21 on the silicon front face which it is important to use phosphoric acid, and this closed the hole in an aluminum oxide, and slept together before.
Next, after being formed in the case of anodic oxidation, the lap of the ball 7 of the anodized array is carried out by ablating mechanically by the approach of common knowledge of side 21. Both diacid-ized silicon 21 and some silicon are removed by this wrapping, the rear face 17 of a ball 7 becomes flat, as shown in 17, a split face is acquired, and for this reason, an ohmic contact can be formed on it. Next, as about 1 / thin foil 19 of 2-mil aluminum is shown in (h), it arranges on the rear face 17 of each ball 7, and it is made to come on the flat field 17 as for which it carried out the lap. Although this aluminum is preferably heated to the temperature within the limits of the temperature of 530 degrees C or about 500 thru/or 577 degrees C, there are conditions which were described above. Therefore, the heated foil 19 is stuck to an impact press by the ball 7 by pressure after this, and the bond part between the aluminum therefore exposed to this impact and the silicon exposed to the wrapping list on the rear face of a ball 7 for the impact by the aluminum element is formed. By joining together the same with having described (d) above, the contact 19 of the foil to the silicon field 11 is formed. On the front face of this foil, a thick aluminum oxide prevents the short circuit between ******, a foil 1, and a foil 19 for anodic oxidation of aluminium foil 1. (As shown in (i), standard antireflection coating can be applied on the field by the side of before an array, and the absorption of light of silicon can be improved.) Therefore, the ingredient with which an array is used for ****** and the processing list used by flexibility is not comparatively expensive, and there are few numbers, and they are making [it exposes to the sunrays in which most balls of silicon carry out incidence, and], and it will be understood that the solar array was offered.
In actual down stream processing, an array which was described above is not as a separate array, and preparing in the example of a reel form is common. Then, an array is formed in a module [as / whose dimension is 1mx2m], and is examined with such designs. Each array formed as stated until now is common although each side is about 10cm.
In order to make a solar array which was described above in a reel form and to form a module, a procedure as shown in Figs. 3 thru/or 6 is followed. If Fig. 3 is explained first, the array interconnect location is shown to this drawing by one dimension. In Fig. 3 (a), one array 30 which fixed the ball 31 to the contact foil member 33 by the side of before is shown, and the backside foil member 35 is not attached in the ball yet. SIMM 37 is inserted between arrays 30 as clearly shown in Fig. 4 (a). Although the foil 33 by the side of before has a dimension smaller than the foil 35 on the backside as shown in Fig. 4 (a), the reason becomes clear later.
Next, when Fig. 3 (b) is seen, it turns out that the foil 35 on the backside touches balls 31 and 37 at this time. The upper foil 33 also touches SIMM. This is the process (h) of Fig. 1 , and when combining the foil 35 on the backside with a ball 31 as a part of this down stream processing, it is attained. Foils 33 and 35 are not pasted up on SIMM 37, but it is only in contact with it. then -- a degree -- SIMM -- a top -- the -- three -- a Fig. -- (-- b --) -- V -- a typeface -- a notation -- a location -- a foil -- a marking-off -- an array -- mutual -- dissociating -- and -- SIMM -- having demounted -- after -- the -- three -- a Fig. -- (-- c --) -- and -- the -- four -- a Fig. -- R -- > -- a Fig. -- (-- c --) -- being shown -- as -- equipment -- making . Next, it bevels, as an array as shown in Figs. (c) (b) 3 and 4 is shown in Fig. 4 (c), and four lugs which are some foils 35 on the backside are made. These lugs are described as ******, and A, B, C and D each square side of an array. Next, as shown in Figs. (d) (d) 3 and 4 , Lugs B, C, and D are turned up under an array, and as shown in a 3rd [**] Fig. R> Fig. (e) after that, this array is fixed to a next array by ultrasonic association etc. by combining Lug A with one of the lugs B and C of an array, or D after this.
An interconnect process can be performed as the equipment of a three-dimensional display of Fig. 5 shows. With this equipment, one array in which Lug A is carrying out extension is positioned so that this one lug A in the lugs B and C of another array or D may contact. This procedure is continued at the path of a straight line or others, and a perfect module is made. The completed module is shown in Fig. 6 , it is fixed to Lugs B and C or D of an array 30 which Lug A adjoins, and the path arranged before and after forming the series circuit of 60 arrays is made. Furthermore, the lug used as the input 41 and output 43 to a module is prepared.
if Fig. 2 is explained, and a module will be examined and it will succeed in a trial after forming the module of Fig. 6 , a module will progress to the charge of supporting material etc. at an attachment **** process, a lug will be ultrasonically combined by the bond part after that, the encapsulation of the module will be carried out after that, and suitable **** to an environment will be given. Next, the module which carried out encapsulation is examined standardly and it will be in the condition that the module which can operate can be used. As mentioned above, the solar array by this invention sets to one of the descriptions to include the semi-conductor member which has the N type field

which carried out ohmic contact association by pressurization under the temperature of 500 degrees C or more at opening of the 1st aluminium foil. According to this description, the impact persistence time at the time of combining a semi-conductor member with opening of the 1st aluminium foil can be shortened, and the solar array suitable for a lot of production is offered.

Although the desirable example of specification [this invention] was explained, to this contractor, I will consider various modification. Therefore, a claim is seen from the conventional technique and should be interpreted as widely as possible so that such all modification may be included.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
Fig. 1 -- this invention -- therefore, the schematic drawing showing down stream processing used to form a solar array, the process diagram showing [2] the process of Fig. 1 , the schematic drawing showing the array interconnect procedure in_which of Fig. 3 expressed with one dimension, the schematic drawing showing the array interconnect procedure which showed Fig. 4 by two-dimensional, the schematic drawing showing the array interconnect which Fig. 5 expressed with the three dimension, and Fig. 6 are the schematic drawing of the module of this invention.
Explanation of a sign
1: The 1st aluminium foil
5: Opening
7: The ball of silicon
9: N type epidermis section
11: The interior of P type
19: The 2nd aluminium foil

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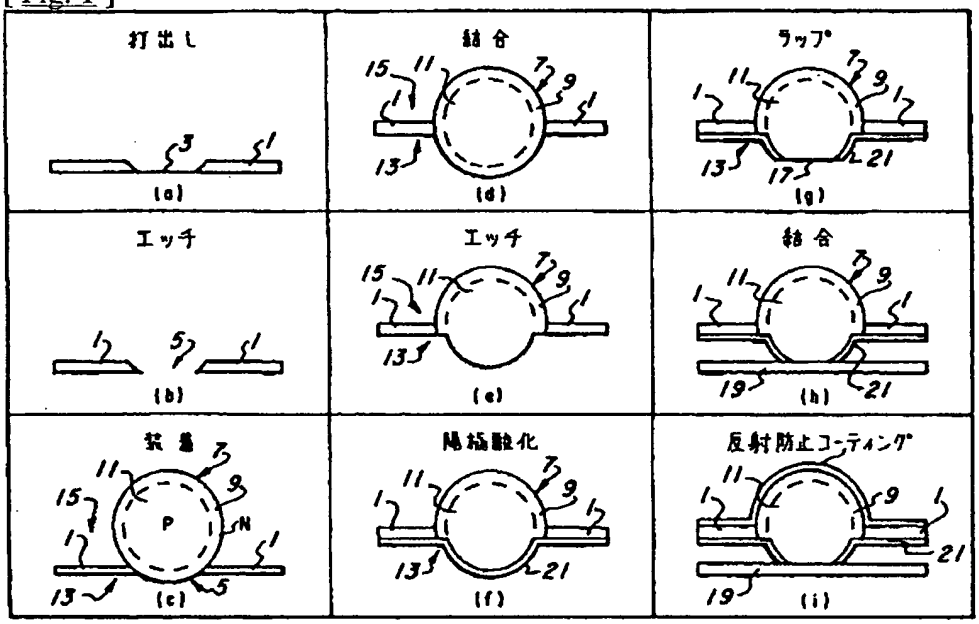
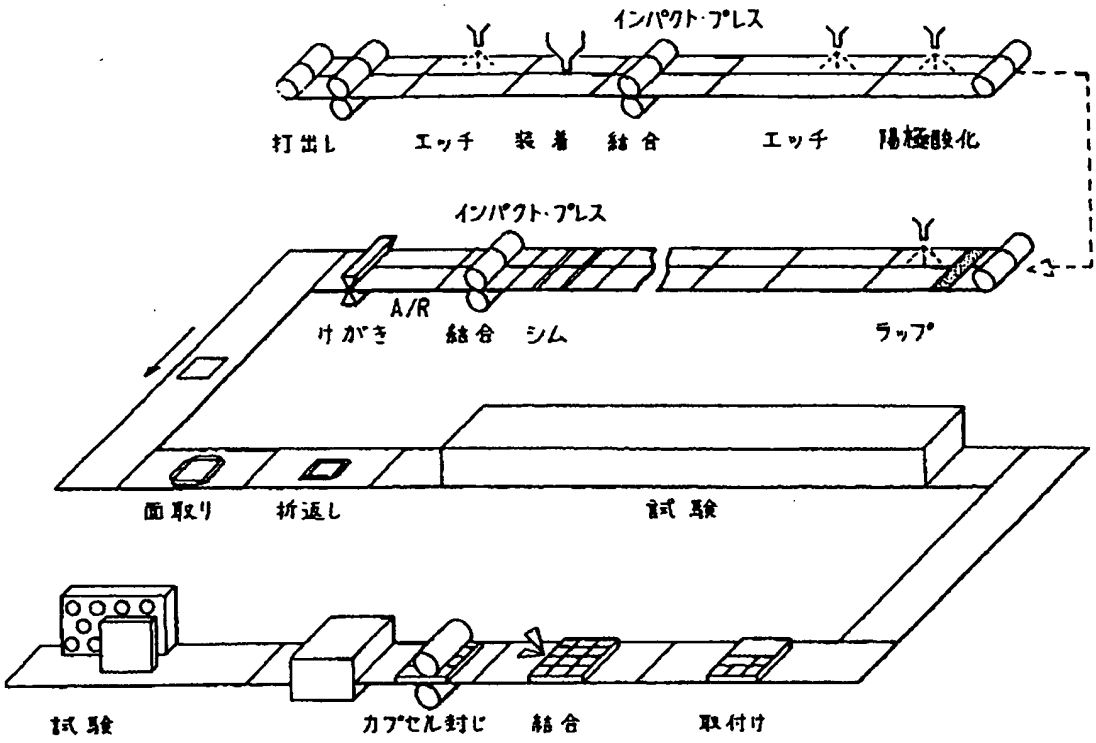
DRAWINGS

[Fig. 1]



[Fig. 2]


インパクト・プレス
打出し
エッチ
装着
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陽極酸化
インパクト・プレス
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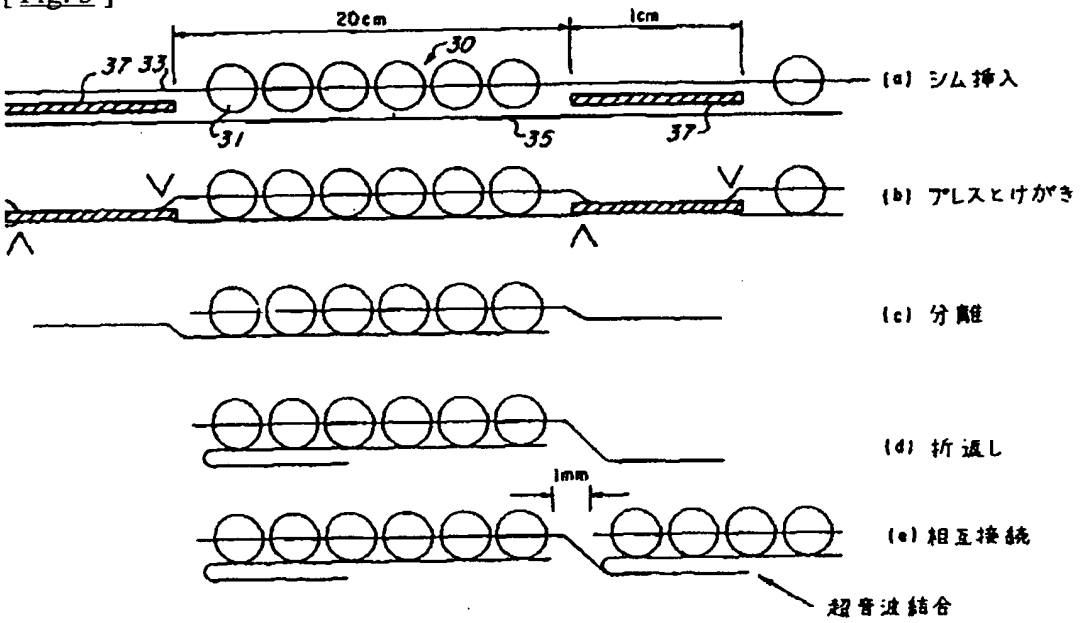
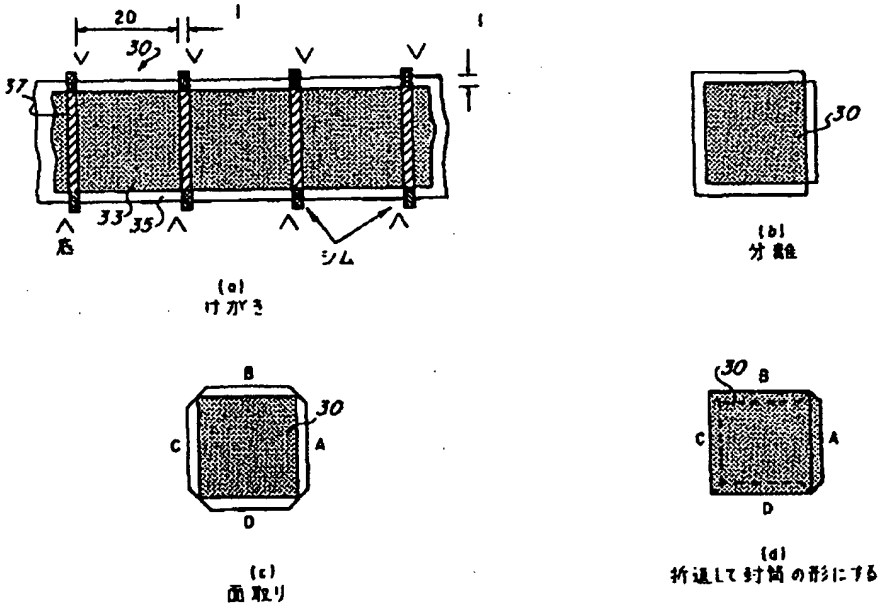
けがき
結合
シム
ラップ
面取り
折返し
試験
試験
カプセル封じ
結合
取付け

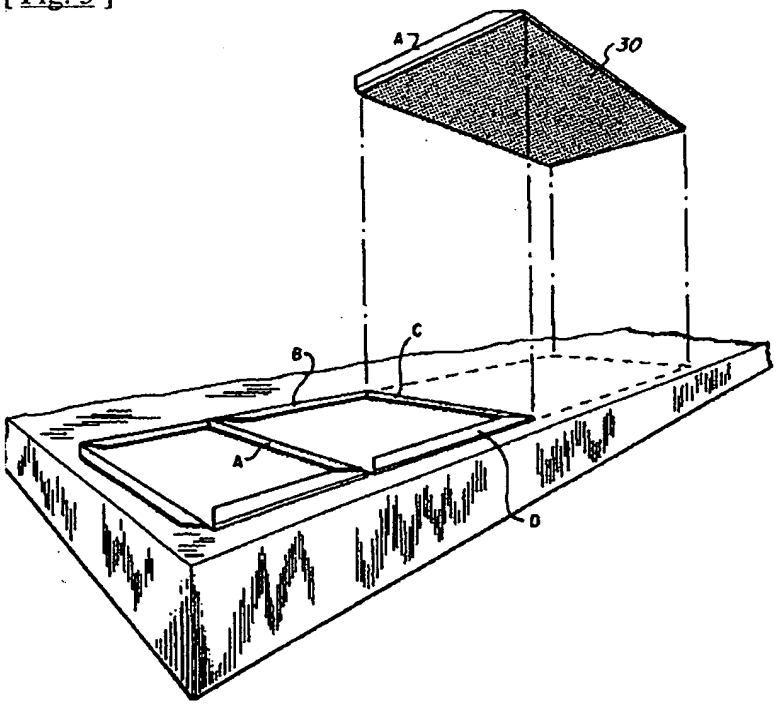
[Fig. 3]


20cm
1cm
37 33
30
31
35
37
(a) シム挿入
(b) プレスとけがき
(c) 分離
(d) 折返し
1mm
(e) 相互接続
超音波結合

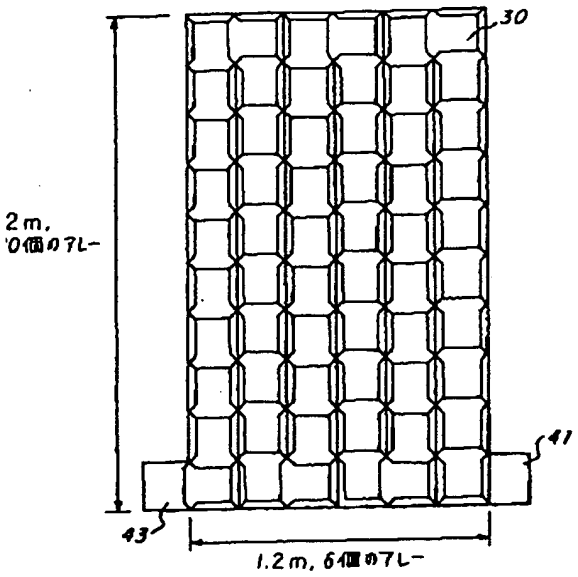
[Fig. 4]



[Fig. 5]



[Fig. 6]



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